

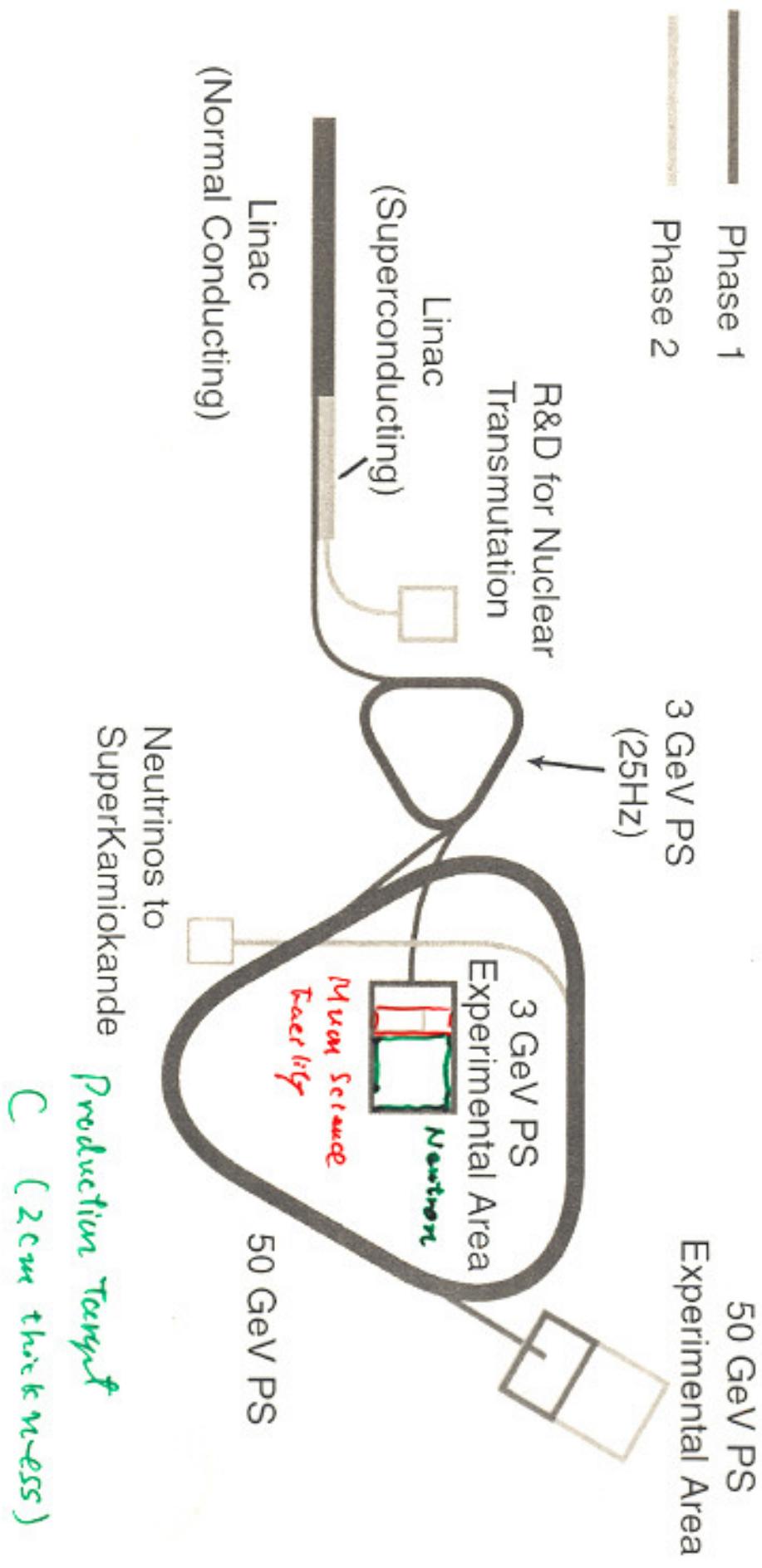
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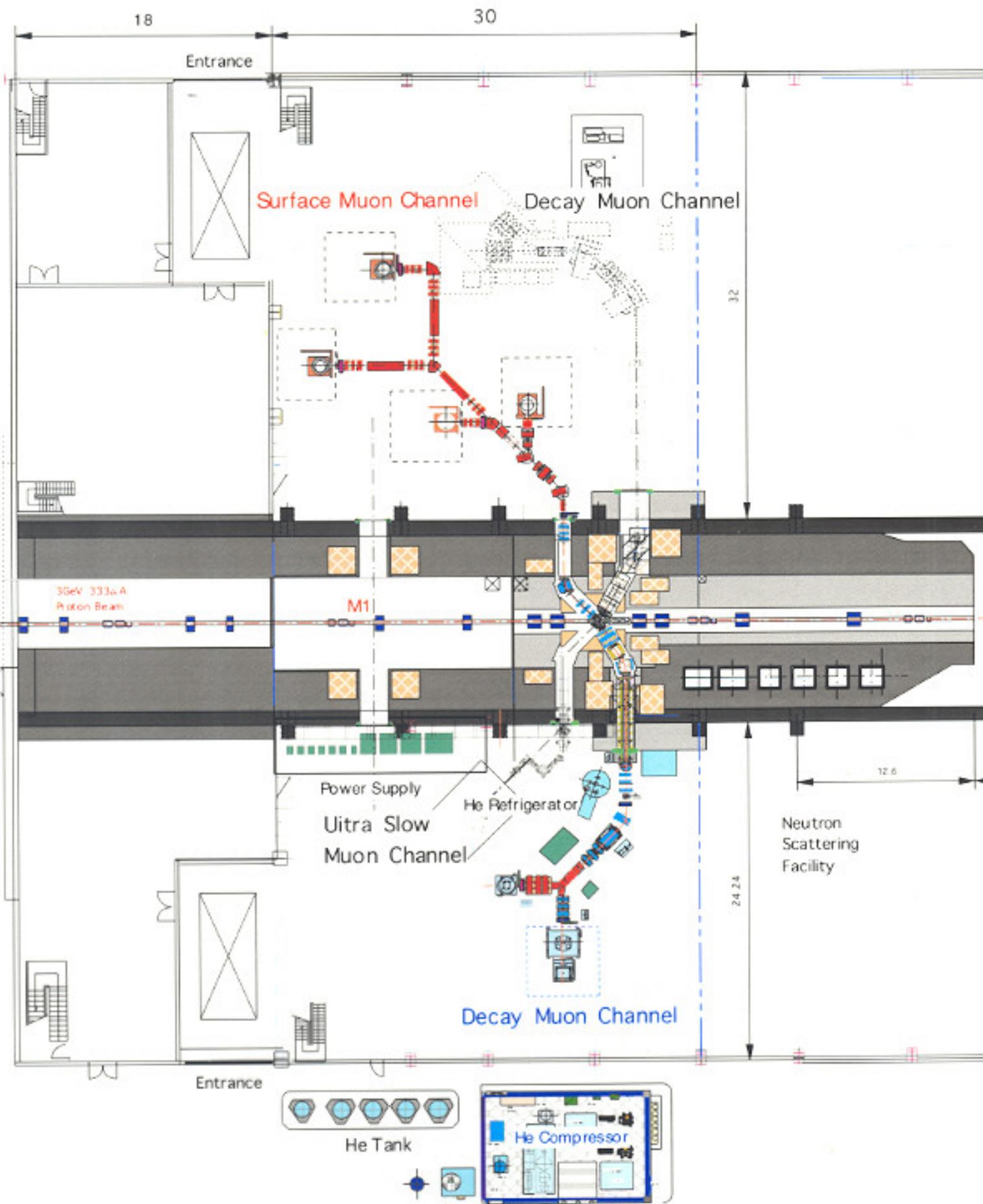
# **Muon Channel at Muon Science Facility and feasibility of super intense surface muon beam**

**K.Shimomura (KEK-MSL)**

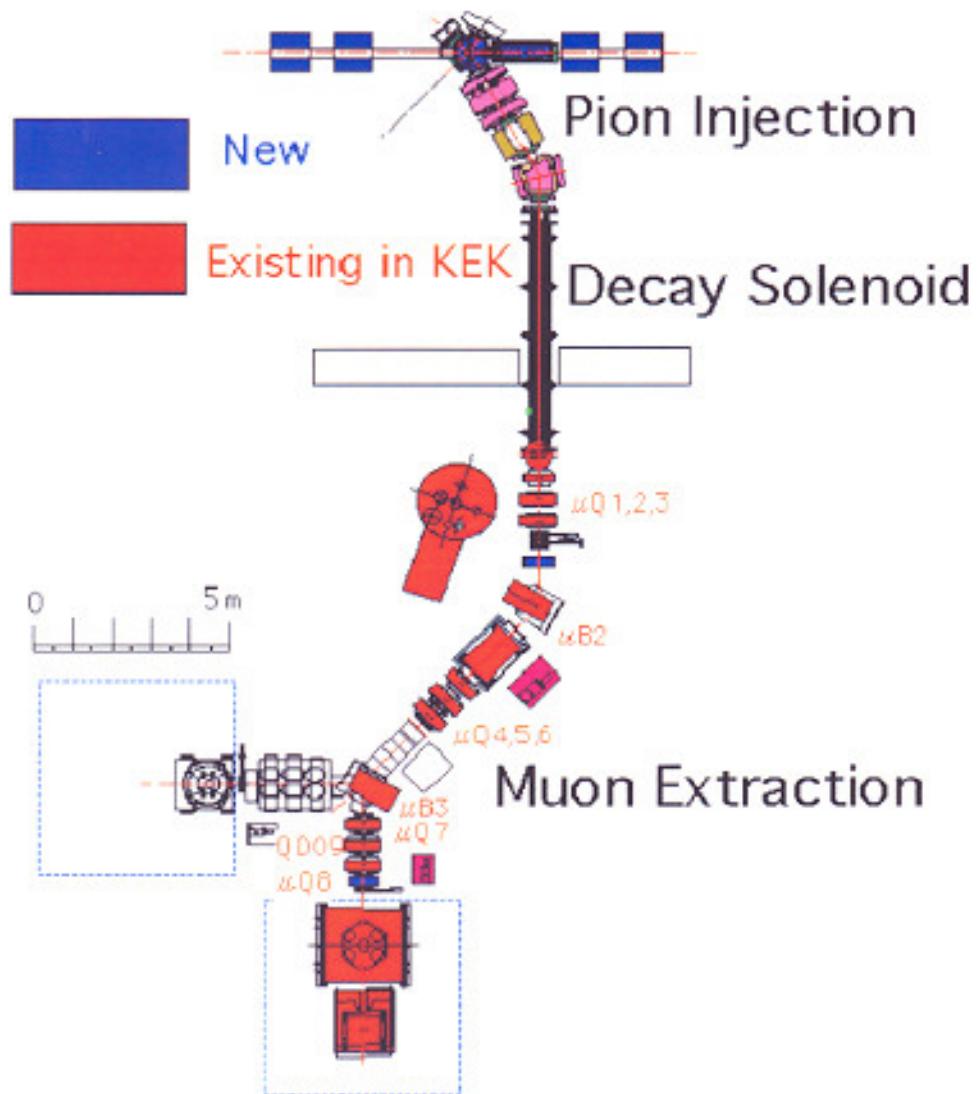
# Phase 1 and Phase 2



# Muon Science Facility Phase 2

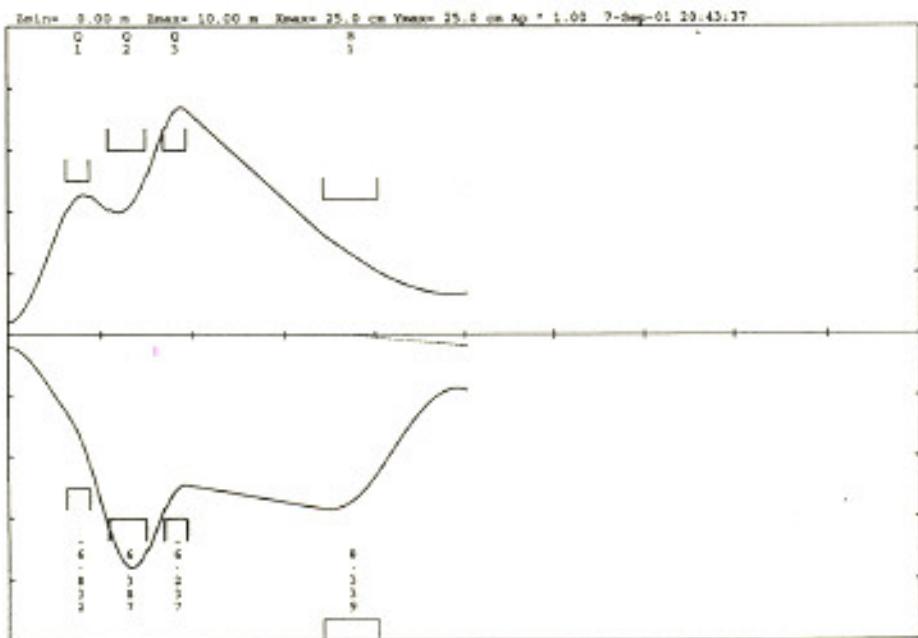
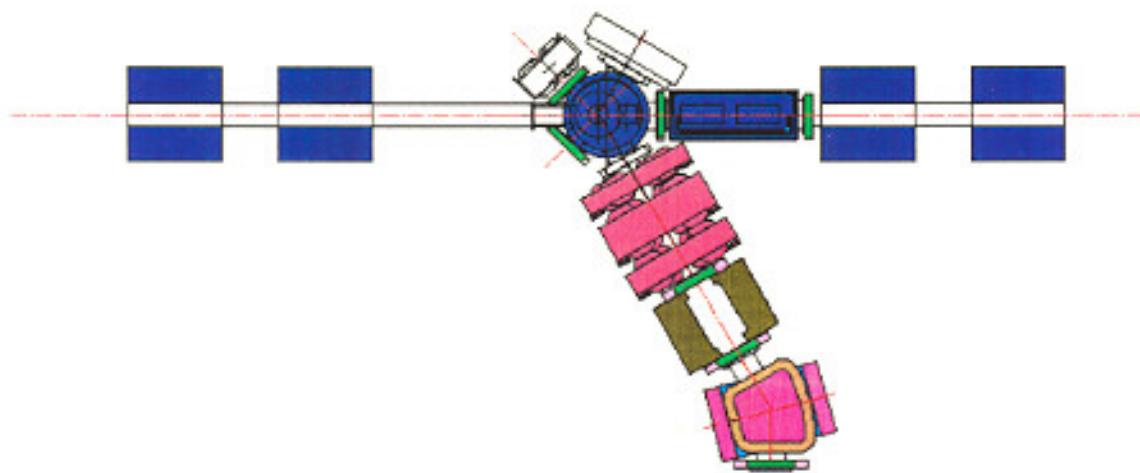


## Superconducting Muon Channel



Magnetic kicker+ Septum Magnet and Q triplet will be installed at Phase2.

# Pion Injector



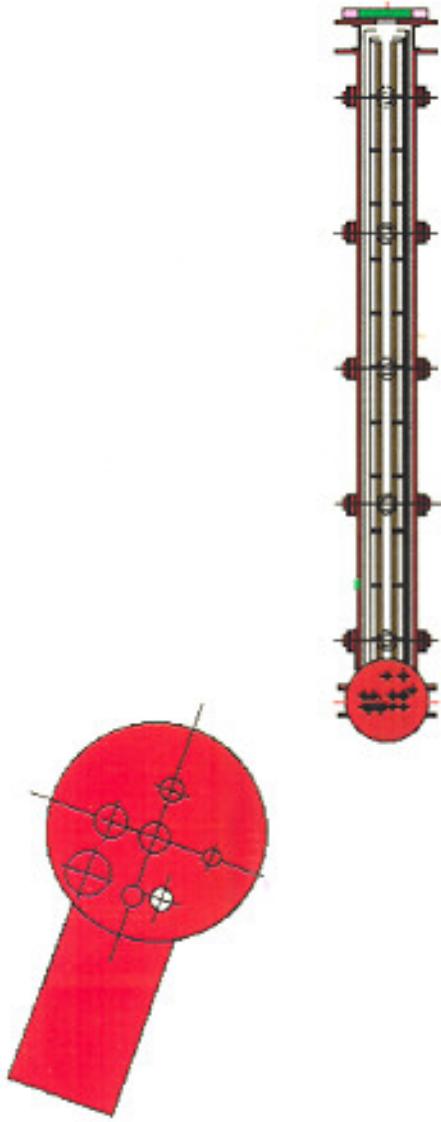
A quadrupole triplet

65msr @ 200 MeV/c

Bending magnet ~~200~~ MeV/c in maximum.  
300

Surface  $\mu^+$  from stopped K at the target  
are also available for muon tomography.

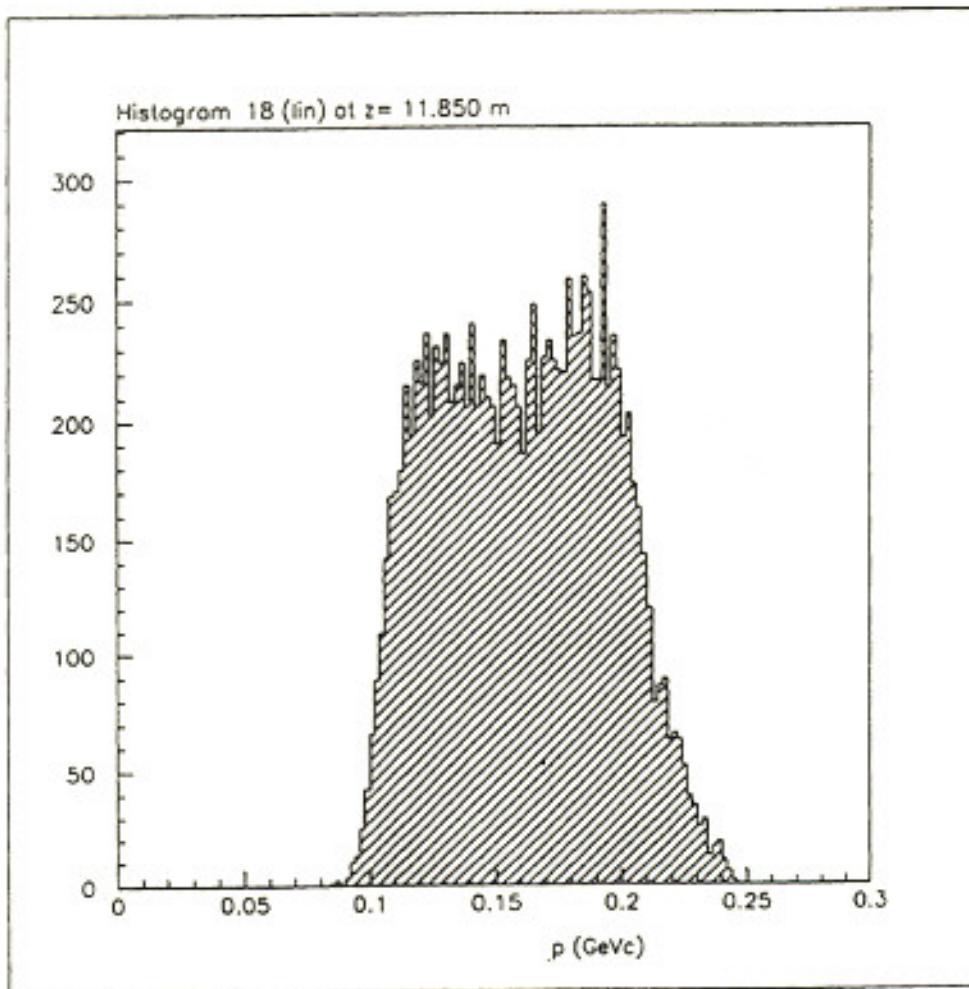
## Decay Solenoid



Length	6m	Bore radius	<del>50cm</del> <sup>6</sup>
Field	<del>60</del> <sup>50</sup> kG		

The currently used solenoid in KEK-MSL  
will be modified for this part.

## Momentum Distribution & Polarization



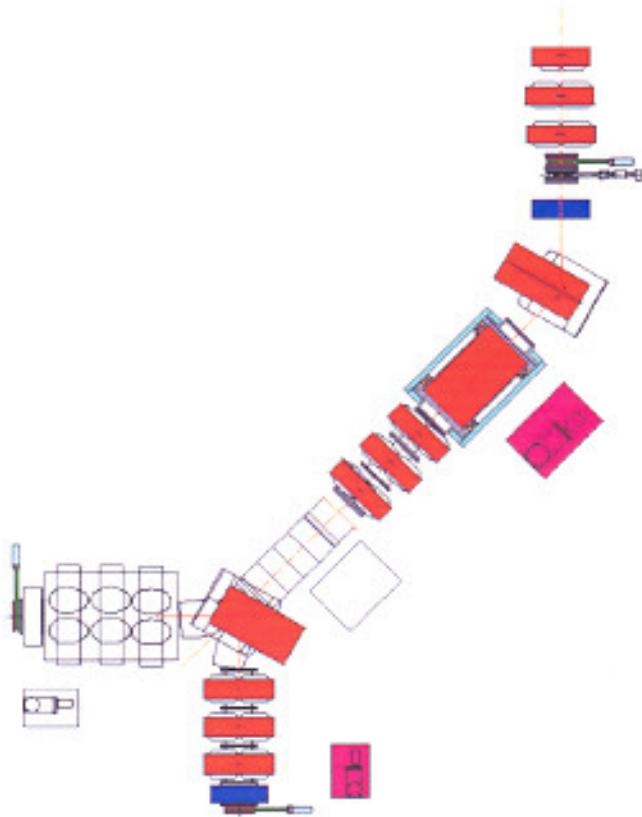
Pion 200MeV/c  $\Delta p = \pm 10\%$

Extracted backward muon  $\sim 120\text{MeV}/c$

Polarization  $\sim 75\%$  (Decay Muon)

$\sim 100\%$  (Surface Muon)

## Muon Extraction



Magnetic kicker+ Septum Magnet and Q triplet will be installed at Phase2.

Solenoid Exit  
40φ

Final Focus Point  
60φ

$E_{\text{extinction}} = X = Y = 2 \text{ nm}$     $\Delta X = \Delta Y = 70 \text{ nm}$ rad    $\Delta P = \pm 5\%$

zmin= -0.00 m zmax= 20.00 m xmax= 25.0 cm ymax= 25.0 cm Ap \* 1.00 5-Jan-01 21:12:34

1  
2  
3  
T  
C  
B  
A  
I  
K  
X  
Y  
Z  
J  
H  
G  
F  
E  
D  
C  
B  
A



## Expected Muon

Surface muon

30MeV/c ( $\Delta p/p=4\%$ )  $3.0 \times 10^7/s$

Decay positive muon

60MeV/c ( $\Delta p/p=10\%$ )  $4.8 \times 10^6/s$

Decay positive muon

120MeV/c ( $\Delta p/p=10\%$ )  $2.2 \times 10^7 p/s$

Decay negative muon

60MeV/c ( $\Delta p/p=10\%$ )  $1.4 \times 10^6/s$

Decay negative muon

120MeV/c ( $\Delta p/p=10\%$ )  $1.0 \times 10^7 /s$

# **Super Intense Surface Muon Channel**

**Progress of muon science**

**ultra slow muon generation**

**muon catalyzed fusion**

**muon rare decay**

**Design study**

**muon collider /neutrino factory**

⇒ several new concepts of the intense muon beam channel are extensively studied.

## **1) KEK-MSL**

**A large solid angle axial focusing  
surface muon channel**

**(Dai Omega)**

**Four sets of superconducting coil  
(1000 msr)**

## **2) PSI**

**New  $\mu$ E4 beam line**

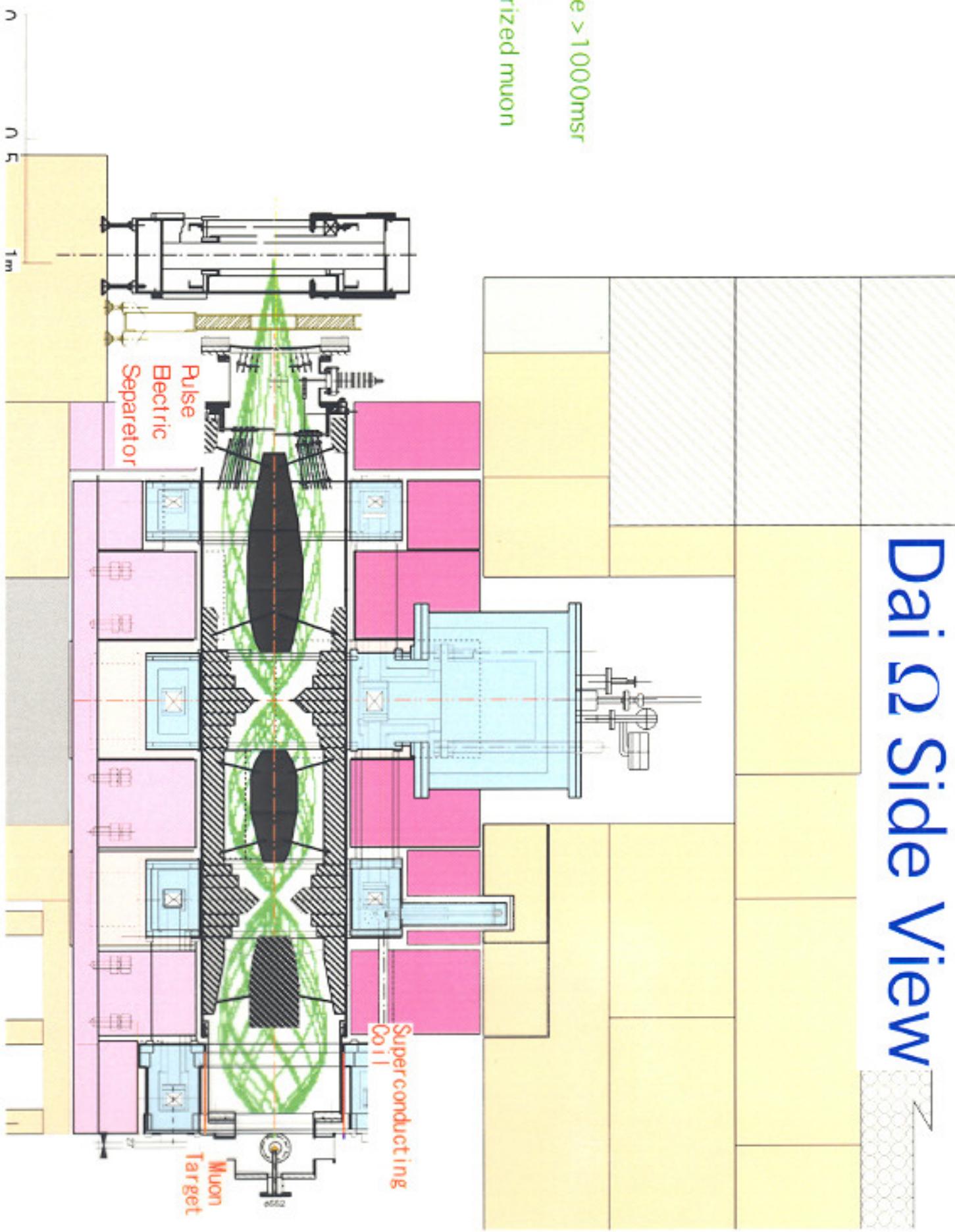
**Two normal solenoids**

**The residual magnetic field at the  
production target is less than 10G**

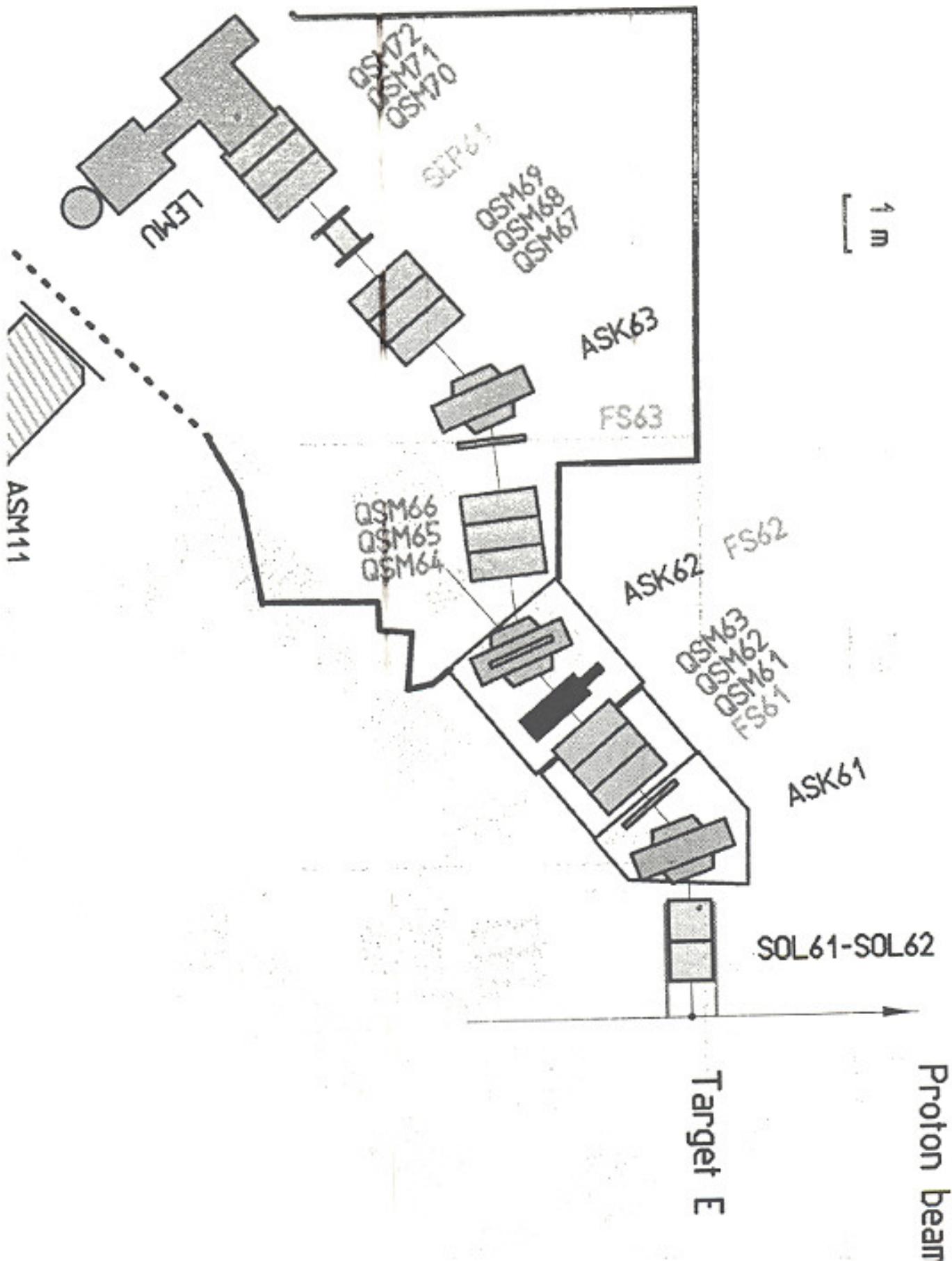
## **3) BNL**

**Bending transport solenoid**

# Dai $\Omega$ Side View



# New $\mu E_4$ secondary beam line (40-34-34)



# 1 Shielded solenoid

## 1.1 Presentation

Here is the geometry of the solenoid :

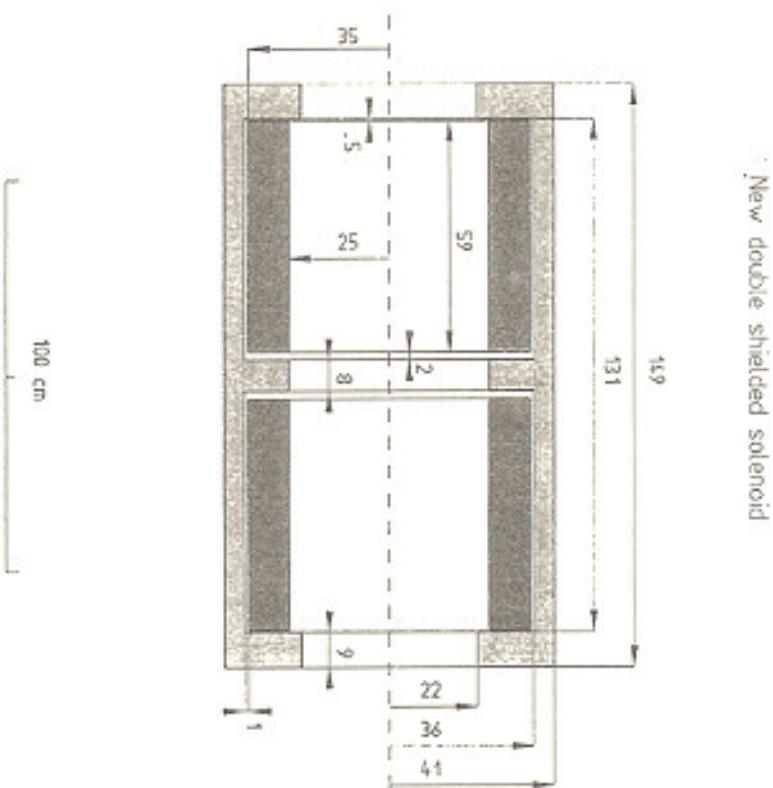


Figure 1:

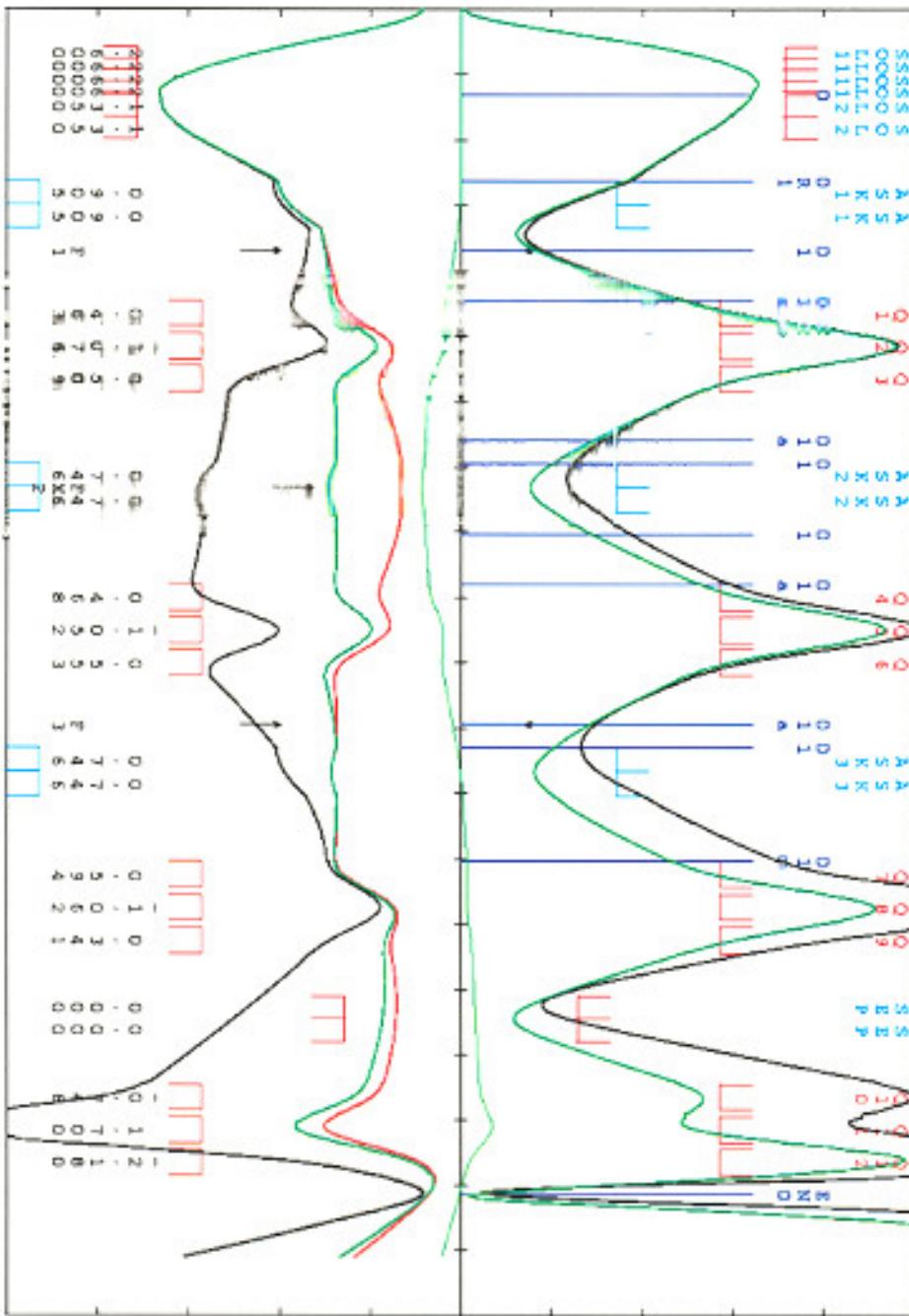
In both side of the middle, there is room for coolers and connectors. The coils have been enlarge from 5 to 10 cm thickness, in order to be used with at most 500 A.



Low Energy > Beam Envelopes  
Beam Envelopes  
Full Intensity mode  
In this model the acceptance solid angle is 1.35 msr and the momentum bite can be tuned between 4.5% and 10% (FWHM) by adjusting the horizontal slit in the second bending magnet (FASOL). The vertical (one-sided) beam envelope is shown in the upper (lower) half of the figure. The red curve is a 1-order calculation with  $d\sigma/dp = 3\%$ , the green one is a 1-order calculation for  $d\sigma/dp = 3\%$  and the black one is the corresponding 2-order beam acceptance. The momentum of the central trajectory is 20 MeV/c. The magnetic field values are given in G.

#### A SR Facilities

New\_muE4\_40-34-34v1.lrc, FFSOLE, symmetric, XZ=210cm, YZ=260cm, PS 80deg, 15deg PPR, NEW PSI  
Zcoll= 0.00 m Zmax= 20.00 m Xmax= 35.0 cm Ymax= 35.0 cm Ap = 1.00 11-Mar-02 17:33:10



By combining the merits of these muon beam lines

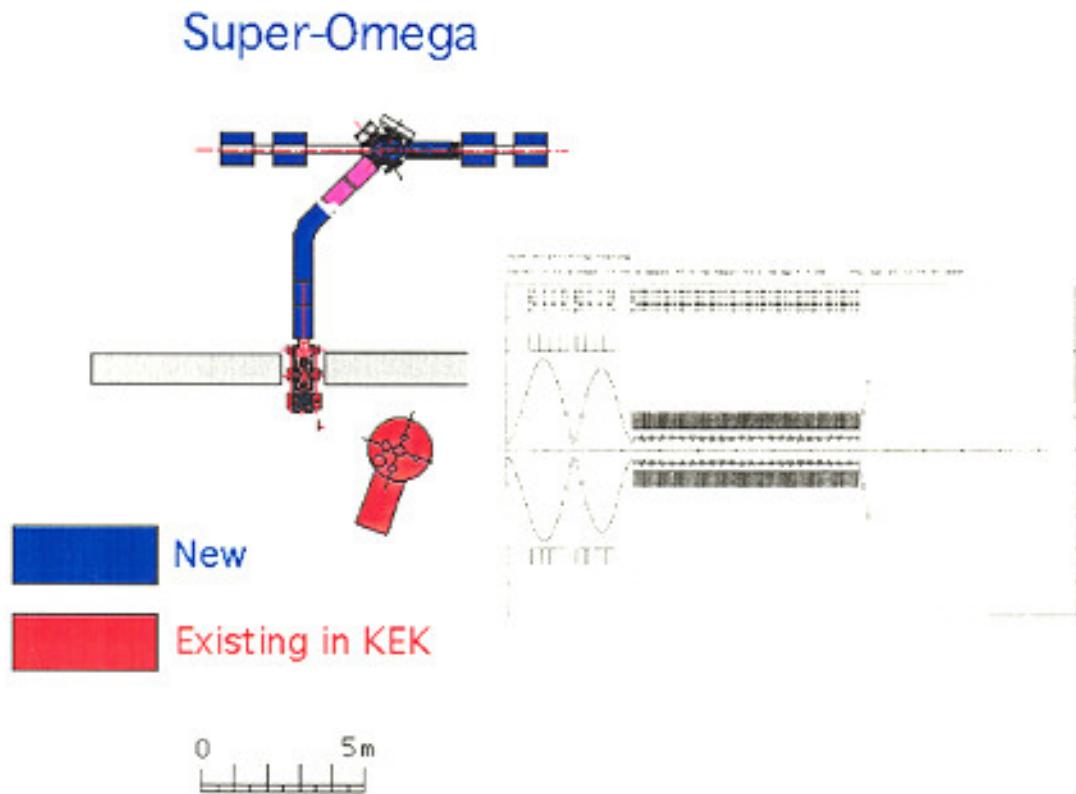
⇒ Possibility of the world highest intensity surface muon channel

## Super-Omega!

Axial focusing optics can achieve a significant acceptance.

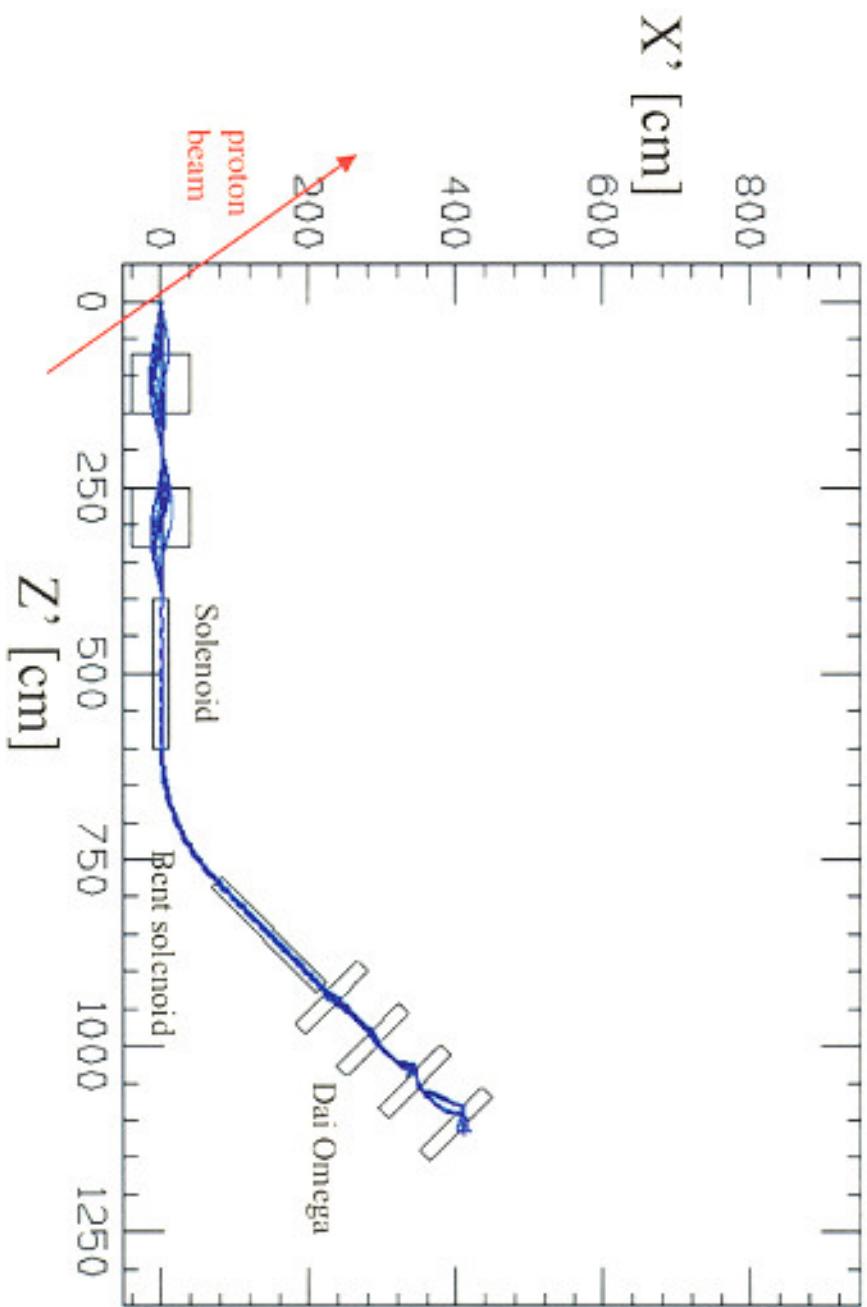
The bending solenoid and Dai Omega are very helpful to reduce neutron background.

# Proposed Layout



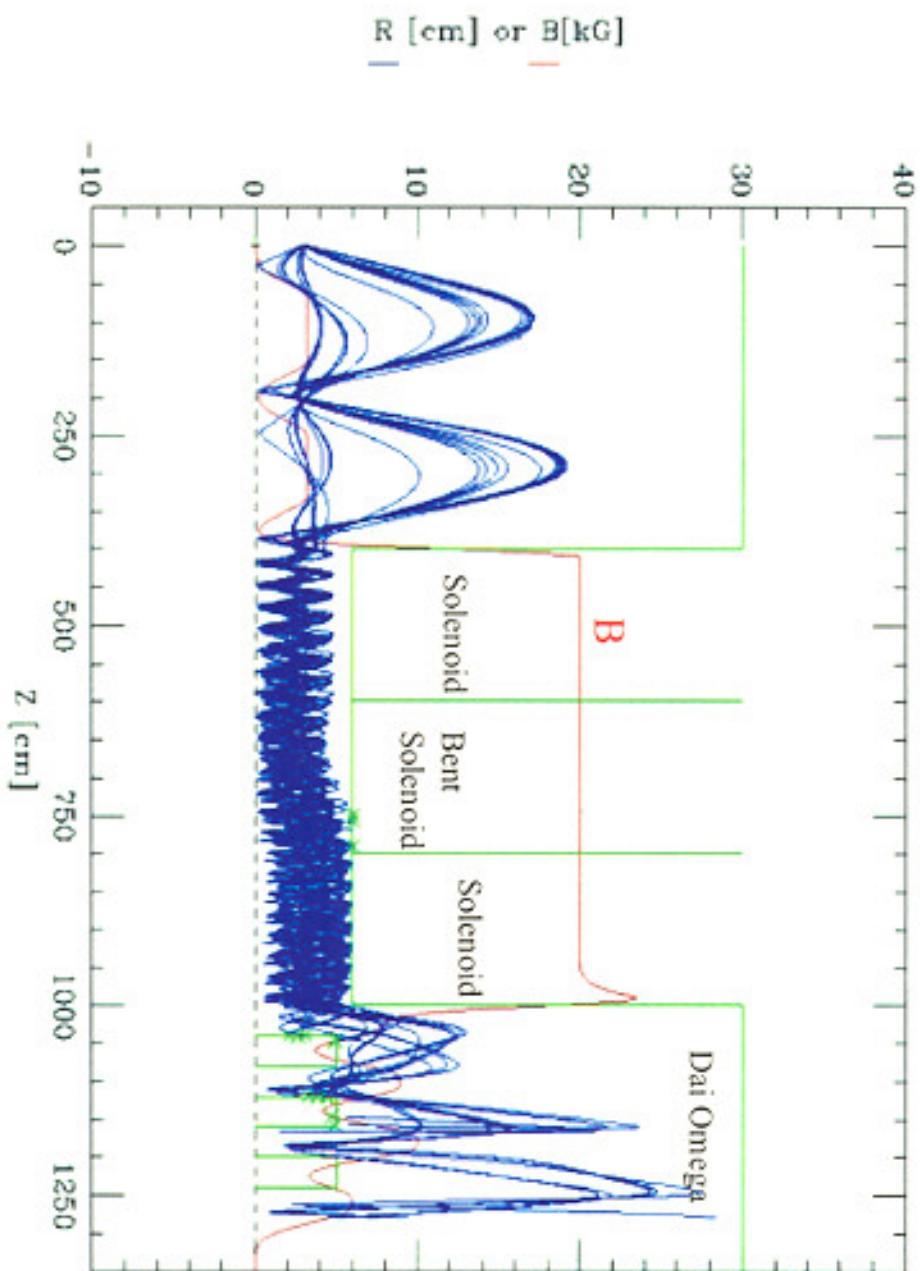
- 1) a double normal conducting solenoid lens**
- 2) a bending superconducting solenoid**
- 3) four axial symmetric superconducting coils**

# Plane view



# Beam shift along path

Curved Solenoid



## **Expected Future Research Projects**

### **High Precision Spectroscopy of Muonium**

**Production of ultra-slow  $\mu^+$  beam  
its application to surface science  
( $\sim 10^5/\text{sec}$ )**

**Mu-Anti Mu Conversion**

**Muon micro-beam production for  
life science application**

**Injector for  $\mu^+$  Acceleration  
New scheme of neutrino factory  
Feasibility Test**